

TUBEROCHERNES (PSEUDOSCORPIONIDA, CHERNETIDAE), A NEW GENUS WITH SPECIES IN CAVES IN CALIFORNIA AND ARIZONA

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ABSTRACT. A new genus, *Tuberochernes*, is defined, the type species being *T. aalbui* new species, from a cave in Mono County, California. Another species referable to the genus is described also, *T. ubicki* new species, from a cave in Santa Cruz County, Arizona. Unique modifications of the palpal chelae and first legs of the males are discussed.

Among some pseudoscorpions collected in caves in California and Arizona by Rolf Aalbu, Derham Giuliani, and Darrell Ubick were some specimens with striking modifications of the palpal chelae and first legs of males. The combination of these features, unique among pseudoscorpions, warrants the description of two new species and the establishment of a new genus.

METHODS

Animals were collected in pitfall traps containing ethylene glycol or directly into alcohol, and were stored in alcohol. Specimens were prepared for detailed study by dissection, clearing in clove oil, and mounting in Canada balsam on microscope slides, generally following the procedure described by Hoff (1949). They were studied and measured under a compound microscope, and drawings were made by direct projection of the image onto paper. The specimens are deposited, as indicated, in the California Academy of Sciences, San Francisco, California (CAS) and the Florida State Collection of Arthropods, Gainesville, Florida (FSCA).

A few abbreviations are used in the text: L = length; L/B = ratio, length/breadth; L/D = ratio, length/depth; T = tactile seta.

Family Chernetidae Menge

Chernetidae Menge 1855:22; Muchmore 1982:101;
Harvey 1991:534 (complete synonymy to 1988);
Harvey 1992:1427.

***Tuberochernes* new genus**

Type species.—*Tuberochernes aalbui* Muchmore new species.

Diagnosis.—*Tuberochernes* is unique among known chernetid pseudoscorpions in the possession of the following suite of characters: 1) cheliceral flagellum of four setae; 2) spermathecae of female consist of two long tubes with terminal sacs; 3) male (but not female) with a conspicuous conical protuberance on the medial side of the hand of the palpal chela; 4) tarsus of leg I of male (but not female) distinctively shortened and curved; 5) tarsus of leg IV (both sexes) with a short, distally located, tactile seta, variably acuminate or finely denticulate. It appears most closely related to *Mirochernes* Beier 1930, from which it can be distinguished readily by the much larger and more complex process on the chelal hand of the latter.

Description.—A genus of the family Chernetidae. Palps well sclerotized, reddish-brown, carapace light brown, other parts lighter. Surfaces of carapace and palps heavily granulate, with slender clavodentate setae. Carapace with two distinct, transverse furrows; without eyes; with 70–100 setae, four at anterior and 12–20 at posterior margin. Most tergites and sternites divided; middle tergites with 25–30 and sternites with about 20 setae. Cheliceral hand usually with six setae (occasionally five), *bs*, *sbs* and *xs* denticulate, *es* short and either acuminate or finely denticulate; flagellum of four setae, the two distal ones long, serrate, the two proximal ones short, simple; galea slender, with 4–6 small rami. Palp rather slender, sexually dimorphic; trochanter, femur and patella of both sexes, and chela of female, typically chernetid in proportions; chela of male heavi-

er than that of female, with a large, broad-based, conical protuberance on medial side of hand, and with movable finger distinctly bowed. Chelal fingers with 45–50 cusped marginal teeth, and with many external and a few internal accessory teeth. Venom apparatus developed only in movable finger. Trichobothria as shown in Fig. 4; on fixed finger, *ist* well distad of *est*, and *ib* distad of *esb*; on movable finger, *st* distinctly closer to *t* than to *sb*. Leg I sexually dimorphic, especially in *T. ubicki* new species; segments more robust in male than in female; tarsus of male curved, while that of female straight. Leg IV quite slender. Tarsus IV with a short, distally located, tactile seta; this seta is sometimes acuminate, sometimes denticulate at tip. Male genitalia typically chernetid in form; spermathecae of female are thin tubes with irregular, ovoid end sacs.

Two species are presently assigned to *Tuberochernes*, namely *T. aalbei* new species from Mono County California, and *T. ubicki* new species from Santa Cruz County, Arizona, as described below.

Tuberochernes aalbei new species

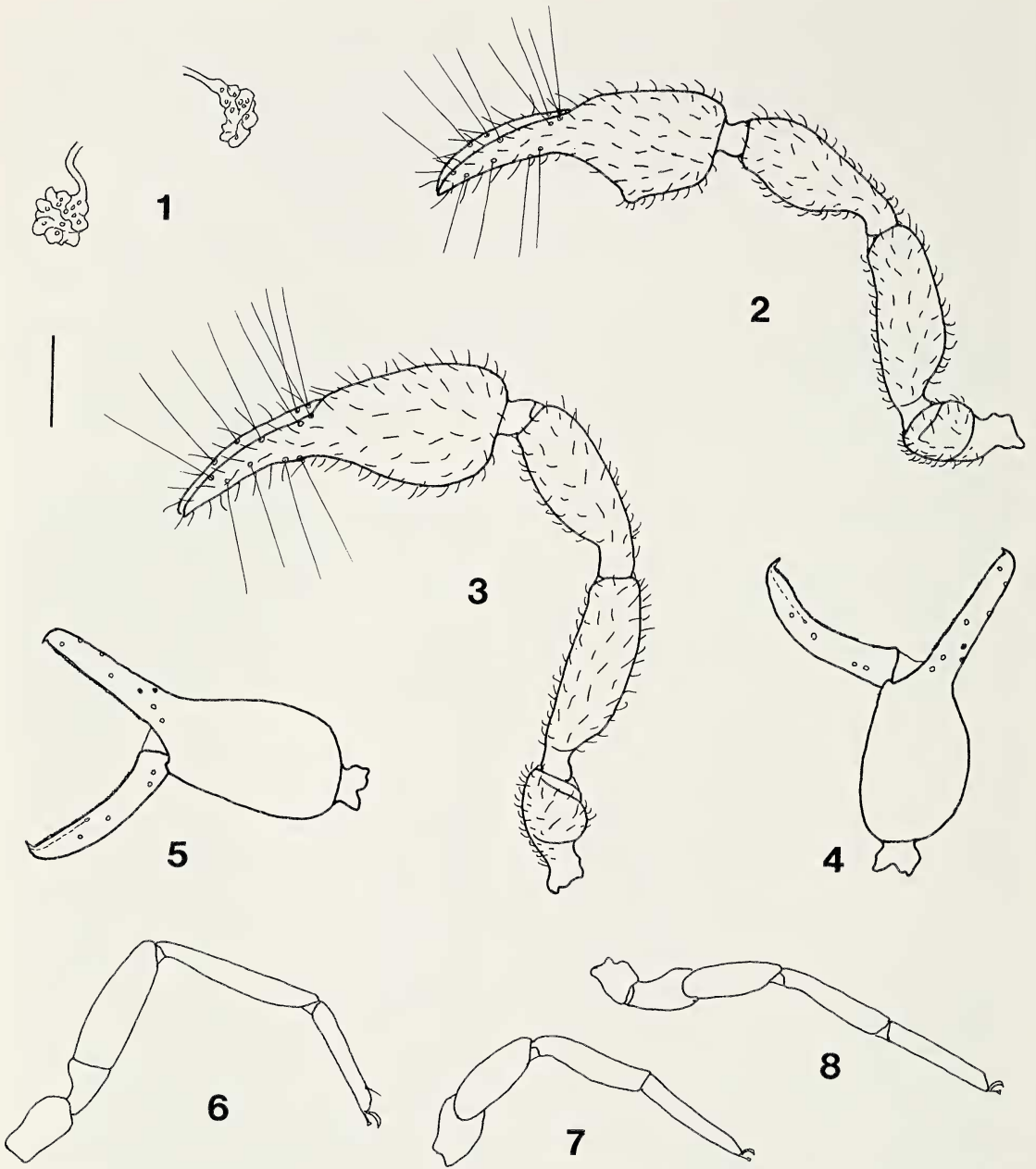
Figs. 1–8

Type data.—Holotype male (WM7269.02005), female paratype (allotype) (WM7269.02008), and about 180 other paratypes (including all stages) taken in ethylene glycol pitfall traps in Poleta Cave, Westgard Pass, Inyo-White Mountains, Inyo County, California, 21 May–5 November 1988, R. Aalbu; holotype, allotype and 28 paratypes (all stages) mounted on slides. Three paratypes (2♀, 1 tritonymph) taken in antifreeze pitfall trap in Poleta Cave (as “Westgard Pass Cave”), 27 May–26 November 1982, D. Giuliani; mounted on slides. All mounted specimens in FSCA, some alcoholic specimens in CAS.

Diagnosis.—Much like *T. ubicki* new species, but specimens larger, palp and leg IV less stout. Tarsus of leg I in *T. aalbei* new species male more similar to that of conspecific female than is the case in *T. ubicki*.

Description.—Male and female similar in most respects, but female usually a little larger, and palpal chelae and first legs sexually dimorphic. Palps reddish-brown, carapace light brown, chelicerae and legs tan. Carapace longer than broad; surface granulate, with two distinct transverse furrows; no eyes; about 80

clavodentate setae, 4 at anterior and 12–16 at posterior margin. Abdominal tergites 1–10 and sternites 4–10 divided; surfaces of tergites lightly granulate; pleural membranes irregularly longitudinally striate; most dorsal setae slender and clavodentate, ventral setae very slender and denticulate or clavodentate. Tergal chaetotaxy of holotype 18:23:21:25:28:26:25:24:24:22:T12T:2, others similar; tactile setae (T) apparently very fragile, as they are usually missing from their areoles. Sternal chaetotaxy of holotype (male) ~50:[33]:(2)29(1):(2)6(2):16:21:21:21:21:18:T1T2T1T:2, other males similar; anterior chaetotaxy of allotype (female) 32:(2)14(2):(3)6(4):14:21:–, other females similar. Internal genitalia of male typically chernetid in form, fairly large and well sclerotized. Spermathecae of female are long tubes with irregular, ovoid end sacs (Fig. 1); the tubes must be thin-walled and fragile, as none could be followed to a medial atrium. Chelicera 0.3 as long as carapace; hand usually with 6 setae (occasionally 5), *bs*, *sbs*, and *xs* terminally denticulate, others acuminate; flagellum of 4 setae, the distal 2 long and anteriorly serrate, the proximal 2 short and terminally denticulate; galea slender, with 5–6 small rami, equally developed in male and female. Palp (Figs. 2, 3) rather long, stouter in male than in female: (numbers for male followed in parentheses by those for female): femur 0.85–0.92 (0.9–1.0) and chela about 1.25 (1.35–1.45)× as long as carapace; L/B of trochanter 1.65–1.95 (1.85–2.15), femur 3.0–3.25 (3.45–3.65), patella 2.65–2.8 (2.8–3.1), and chela (without pedicel) 2.5–2.8 (2.8–3.1); L/D of hand (without pedicel) 1.4–1.55 (1.5–1.7); movable finger L/hand L 0.95–1.1. Chela of male quite robust, with a conspicuous, conical protuberance on medial side of hand, and with movable finger distinctly bowed (Fig. 4); chela of female more slender and without these features. Surfaces lightly granulate; most setae narrow clavodentate. Trichobothria as shown in Figs. 4, 5. Each finger with 45–50 contiguous, cusped marginal teeth; fixed finger with 9–11 external and 3–6 internal, and movable finger with 5–10 external and 1–2 internal accessory teeth. Venom apparatus present only in movable finger, nodus ramosus between trichobothria *t* and *st*. Legs slender: leg IV (Fig. 6) with L/D of femur+patella 4.4–4.85, tibia 7.0–7.8, and tarsus 6.35–7.45. Leg I of male (Fig. 7) with tarsus slightly



Figures 1-8.—*Tuberochernes aalbei* new species. 1, Spermathecae of allotype female; 2, Right palp of holotype male, dorsal view; 3, Right palp of allotype female, dorsal view; 4, Left chela of paratype male, lateral view, showing trichobothriotaxy (all setae omitted; darkened areoles are underneath); 5, Left chela of allotype female; 6, Leg IV of holotype male (vestitural setae omitted); 7, Leg I of holotype male. 8, Leg I of allotype female. Scale bar = 0.15 mm for Fig. 1, and 0.5 mm for all others.

bowed, concave dorsally; that of female (Fig. 8) normal, straight. Leg IV with a short tactile seta on tarsus 0.75-0.8 length of segment from proximal end; these setae are variably acuminate or terminally denticulate.

Nymphs: Generally similar to adults, but progressively smaller, lighter in color, and with appendages slightly more robust. Hand of chelicera with fewer setae: tritonymph with 5 or 6 (*xs* sometimes absent), deutonymph

with 5 (*xs* absent), and protonymph with 4 (*xs* and *bs* absent); flagellum with 4 setae in all stages. Palp: fixed and movable fingers bear the typical numbers of trichobothria for each stage. Leg IV: tarsus bears a short, acuminate tactile seta 0.65–0.7 length of segment from proximal end.

Measurements.—*Male*: Figures given first for holotype, followed in parentheses by ranges for seven paratypes. Body L 4.22 (3.85–4.68). Carapace L 1.30 (1.21–1.35). Chelicera L 0.37 (0.37–0.42). Palp: trochanter 0.63 (0.62–0.695)/0.34 (0.325–0.38); femur 1.13 (1.06–1.23)/0.355 (0.34–0.41); patella 1.01 (1.00–1.11)/0.37 (0.37–0.415); chela (without pedicel) 1.61 (1.56–1.70)/0.59 (0.555–0.665); hand (without pedicel) 0.815 (0.82–0.92)/0.555 (0.53–0.62); pedicel L 0.15 (0.13–0.16); movable finger L 0.89 (0.83–0.925). Leg I: femur+patella L 0.83 (0.815–0.90); femur 0.455 (0.43–0.48)/0.235 (0.235–0.265); patella 0.58 (0.56–0.62)/0.19 (0.19–0.23); tibia 0.67 (0.64–0.75)/0.13 (0.14–0.16); tarsus 0.615 (0.57–0.70)/0.105 (0.09–0.11). Leg IV: femur+patella 1.02 (0.97–1.10)/0.23 (0.215–0.245); tibia 0.92 (0.865–1.02)/0.125 (0.125–0.14); tarsus 0.665 (0.615–0.74)/0.105 (0.095–0.11).

Female: Figures given first for allotype, followed in parentheses by ranges for 12 paratypes. Body L 4.40 (3.65–4.85). Carapace L 1.29 (1.16–1.34). Chelicera L 0.39 (0.355–0.41). Palp: trochanter 0.665 (0.615–0.69)/0.32 (0.29–0.34); femur 1.18 (1.07–1.24)/0.34 (0.30–0.36); patella 1.06 (0.955–1.11)/0.38 (0.34–0.415); chela (without pedicel) 1.85 (1.61–1.88)/0.62 (0.525–0.635); hand (without pedicel) 0.95 (0.83–1.01)/0.585 (0.51–0.62); pedicel L 0.13 (0.11–0.13); movable finger L 0.93 (0.83–0.955). Leg I: femur+patella L 0.835 (0.74–0.87); femur 0.42 (0.36–0.45)/0.215 (0.185–0.22); patella 0.56 (0.52–0.605)/0.18 (0.16–0.19); tibia 0.65 (0.58–0.70)/0.125 (0.11–0.125); tarsus 0.63 (0.58–0.69)/0.095 (0.09–0.095). Leg IV: femur+patella 1.07 (0.985–1.13)/0.22 (0.205–0.245); tibia 0.955 (0.865–1.04)/0.13 (0.11–0.13); tarsus 0.70 (0.635–0.725)/0.095 (0.09–0.105).

Tritonymph: Ranges for five paratypes. Body L 2.85–3.30. Carapace L 0.89–1.05. Chelicera L 0.28–0.325. Palp: trochanter 0.445–0.52/0.22–0.27; femur 0.725–0.89/0.235–0.29; patella 0.635–0.785/0.265–0.325;

chela (without pedicel) 1.23–1.43/0.435–0.50; hand (without pedicel) 0.63–0.73/0.43–0.495; pedicel L 0.08–0.09; movable finger L 0.665–0.74. Leg IV: femur+patella 0.69–0.82/0.16–0.19; tibia 0.57–0.665/0.105–0.12; tarsus 0.45–0.525/0.08–0.09.

Deutonymph: Ranges for three paratypes. Body L 1.95–2.25. Carapace L 0.615–0.67. Chelicera L 0.20–0.25. Palp: trochanter 0.30–0.35/0.15–0.18; femur 0.47–0.55/0.15–0.185; patella 0.42–0.48/0.17–0.215; chela (without pedicel) 0.83–0.96/0.26–0.325; hand (without pedicel) 0.415–0.495/0.26–0.31; pedicel L 0.05–0.07; movable finger L 0.46–0.495. Leg IV: femur+patella 0.445–0.525/0.12–0.135.

Protonymph: Ranges for three paratypes. Body L 1.45–1.75. Carapace L 0.48–0.56. Chelicera L 0.185–0.19. Palp: trochanter 0.235–0.245/0.12–0.125; femur 0.34–0.355/0.115–0.125; patella 0.31/0.13–0.14; chela (without pedicel) 0.615–0.65/0.18–0.20; hand (without pedicel) 0.32–0.33/0.18–0.19; pedicel L 0.04; movable finger L 0.325–0.35.

Etymology.—The species is named in honor of Rolf Aalbu, who collected most of the type specimens.

Remarks.—The first legs of the male are somewhat modified compared to those of the female, though not so much so as in *T. ubicki* (see below).

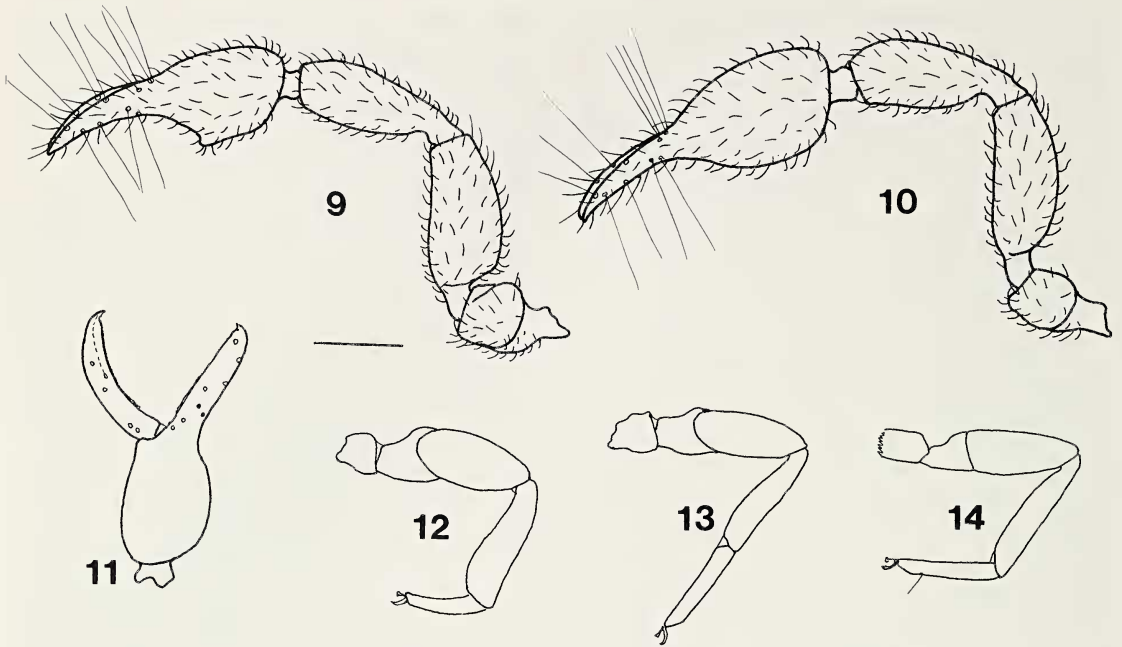
Tuberochernes ubicki new species

Figs. 9–14

Type data.—Holotype male (WM7729.01001) and female paratype (allotype) (WM7729.01002) from under stones in Fly Cave, Gardner Canyon, Santa Rita Mountains, Santa Cruz County, Arizona, 24 June 1988, D. Ubick; mounted on slides, in CAS.

Diagnosis.—Much like *T. aalbui*, but a little smaller, with palp and leg IV a little stouter, and leg I of male apparently raptorial, the segments being distinctly modified.

Description.—Male and female generally similar, but female a little larger, and palpal chelae and first legs sexually dimorphic. Palps reddish-brown, carapace light brown, chelicerae and legs tan, other parts lighter. Carapace longer than broad; surface covered with low granules and with two distinct, transverse furrows; no eyes; about 90–100 clavodentate setae, 4 at anterior and 18–20 at posterior margin. Abdominal tergites 2–10 and sternites 4–10 divided; surface of tergites lightly granulate;



Figures 9–14.—*Tuberochernes ubicki* new species. 9, Right palp of holotype male, dorsal view; 10, Right palp of allotype female, dorsal view; 11, Left chela of holotype male, lateral view, showing trichobothriotaxy (all setae omitted; darkened areoles are underneath); 12, Leg I of holotype male (vestitural setae omitted); 13, Leg I of allotype female; 14, Leg IV of holotype male. Scale bar = 0.5 mm.

pleural membranes irregularly longitudinally striate; most dorsal setae slender, clavodentate, ventral setae slender, acuminate to clavodentate. Tergal chaetotaxy of holotype 20:28:26:28:27:29:30:26:23:21:T12T:2. Sternal chaetotaxy of holotype (male) 60:[4–4]:(1)25(1):(1)6(1):15:20:20:20:20:18:T2T2T1T:2; anterior chaetotaxy of allotype (female) 34:(1)9(1):(1)5(1):16:22:–. Internal genitalia of male typically chernetid in form; spermathecae of female not clear, but apparently like those of *T. aalbui* new species. Chelicera 0.25 as long as carapace; hand with 6 setae, *is* and *ls* long, acuminate, others rather short and terminally denticulate; flagellum of 4 setae, distal 2 long and serrate, proximal 2 short and denticulate near tip; galea of male small, with 3–4 spinules, that of female longer, slender, with 6 small rami. Palp rather robust (Figs. 9, 10): (numbers for male followed in parentheses by those for female). Femur 0.9 (0.95) and chela 1.15× (1.35) as long as carapace. L/B of trochanter 1.5 (1.85), femur 2.6 (2.95), patella 2.8 (2.7), and chela (without pedicel) 2.7 (2.7); L/D of hand (without pedicel) 1.55 (1.45); movable finger L / hand L 1.15 (0.95). Chela sexually dimorphic; that of male more robust,

with a conical protuberance on medial side of hand, and with movable finger distinctly bowed (Fig. 11); that of female more slender, without a protuberance on hand, and with movable finger only gently curved. Surfaces granulate; most setae clavodentate. Trichobothria as shown in Fig. 11. Fixed finger with about 45 and movable finger with 45–50 cusped marginal teeth, and 1–3 internal and 7–9 external accessory teeth. Venom apparatus developed only in movable finger. Legs more robust than those of *T. aalbui*: leg IV (Fig. 14) with L/D of femur+patella 3.8 and tibia 6.0. Leg I sexually dimorphic: that of male apparently raptorial, with robust femur, patella and tibia, and elongate, curved tarsus (Fig. 12), L/D of femur+patella 2.75 and tibia 3.6; leg I of female normal, slender (Fig. 13), L/D of femur+patella 3.35 and tibia 4.55. Tarsus of leg IV with a short acuminate or denticulate tactile seta 0.75 length of segment from proximal end.

Measurements.—Figures given first for holotype male, followed in parentheses by those for allotype female. Body L 3.55 (4.12). Carapace L 1.18 (1.20). Chelicera L 0.30 (0.355). Palp: trochanter 0.63 (0.605)/0.385 (0.325); femur 1.04 (1.10)/0.40 (0.37); patella

0.99 (1.02)/0.35 (0.38); chela (without pedicel) 1.36 (1.60)/0.50 (0.59); hand (without pedicel) 0.69 (0.85)/0.45 (0.585); pedicel L 0.13 (0.12); movable finger L 0.78 (0.82). Leg I: femur+patella L 0.895 (0.925); femur 0.38 (0.33)/0.31 (0.215); patella 0.63 (0.525)/0.30 (0.20); tibia 0.755 (0.59)/0.21 (0.13); tarsus 0.47 (0.495)/0.09 (0.08). Leg IV: femur+patella 0.895 (0.925)/0.235 (0.24); tibia 0.835 (0.835)/0.14 (0.13); tarsus 0.58 (0.59)/0.095 (0.095).

Etymology.—The species is named for Darrell Ubick, who collected the type specimens.

Remarks.—The first legs of the male look as though they might be very useful in seizing or holding prey, but there is no direct evidence that this is so. They might, rather, be used in grasping the female during courtship and sperm transfer, which, in some chernetid pseudoscorpions, can involve rather complex maneuvers (see Weygoldt 1969).

DISCUSSION

Several other genera of chernetid pseudoscorpions have medial protuberances on the palpal chela. *Tuberochernes* is easily distinguished from *Mirochernes* Beier 1930 (from eastern U.S.), in which the male has a very large, distally directed, hooklike process (Hoff 1949: fig. 45C). And it differs from *Interchernes* Muchmore 1980 (from Baja California, Mexico), where the process is a small, discrete, conical nubbin located at the base of the fixed finger and is present in both sexes (Muchmore 1980). *Bituberochernes* Muchmore 1974 (from Florida and the West Indies), likewise, has a small process at base of the fixed finger, but it differs fundamentally from *Tuberochernes* in having a three-bladed cheliceral flagellum, distinctive female genitalia, and highly specialized setae on leg I of the male (see Muchmore 1974b, 1979). *Petterchernes* Heurtault 1986 (from Brazil), with a large hump on the chelal hand, has a three-bladed flagellum, and broad, leaflike setae (Heurtault 1986). No other chernetid pseudoscorpions are known to have protuberances on the chelal hand. *Cordylochernes octentoctus* (Balzan 1891) (from South Africa?) was originally illustrated as having a triangular tubercle on the base of the fixed chelal finger (Balzan 1891: fig. 5); however, Vachon (1942), on reexamination of the unique type of the spe-

cies, found that the protuberance was actually a bit of foreign material stuck to the surface of the finger.

Of the genera mentioned above, *Tuberochernes* is more closely related to *Mirochernes* and *Interchernes*, in the possession of a four-bladed flagellum, paired, long, slender, tubular spermathecae, and other characters (see Muchmore 1974a). In these characters also, it is close to *Chernes* Menge 1855, *Dinocheirus* Chamberlin 1929 and *Hesperochernes* Chamberlin 1924, all widely distributed in the United States.

In addition to the distinctive medial protuberance on the chelal hand, males of *Tuberochernes* have a uniquely modified leg I (more so in *T. ubicki* than in *T. aalbui*). All segments of the first legs are more robust than in females and the tarsus is curved, so that, in *T. ubicki* especially, it appears useful for seizing or grasping. The exact nature of the modifications of the anterior appendages is not known, but, as they are found only in the males, it might be supposed that they are somehow related to courtship and mating. On the other hand, known species of the genus are found only in caves, and these may be adaptations to some aspect of life in that habitat.

Though it is common in cheliferid pseudoscorpions, sexually dimorphic modification of the first legs is rare in chernetids. Representatives of only three chernetid genera have been known previously to be so modified, namely, *Pachychernes* Beier 1932 from South and Central America, *Orochernes* Beier 1968 from Nepal and Siberia and *Bituberochernes* Muchmore 1974 from Florida and the West Indies (see Muchmore 1996). In all of these, the modifications involve the occurrence of very long, or short, specialized, setae, which are not present in *Tuberochernes* species.

Representatives of *Tuberochernes* are presently known only from caves at moderately high elevations, *T. aalbui* in Poleta Cave, Westgard Pass, White-Inyo Mountains, Inyo County, California, at about 2200 m elevation, and *T. ubicki* in Fly Cave, Gardner Canyon, Santa Rita Mountains, Santa Cruz County, Arizona, at about 1600 m. The widely separated and restricted localities of *T. aalbui* and *T. ubicki* in California and Arizona strongly suggest that these species are relicts of a formerly widespread ancestral population, fragmented

by desertification in the intervening areas. Similar disjunct patterns of distribution in California and Arizona have been observed in several other groups of arachnids: the antrodiaetid spiders *Aliatypus janus* Coyle 1974 and *A. isolatus* Coyle 1974 (see Coyle 1974); the vaejovid scorpions *Uroctonites giulianii* Williams & Savary 1991 and *U. huachuca* (Gertsch & Sologlad 1972) (see Williams & Savary 1991); the hubbardiid schizomids *Hubbardia borregoensis* (Briggs & Hom 1966) and *H. wessoni* (R.V. Chamberlin 1939) (see Reddell & Cokendolpher 1995); two species of the phalangodid harvestman genus *Sitalcina* Banks 1911 (Ubick & Briggs, unpubl.); and others. It will not be surprising if additional representatives of *Tuberochernes* are found in other montane or subterranean refugia in California and Arizona.

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